Moscosoa 5, 1989, pp. 216-225

TWO ATYPICAL EXAMPLES OF SEED DISTRIBUTION IN THE DOMINICAN REPUBLIC

Richard A. Howard & Thomas A. Zanoni

Howard, Richard A. (Arnold Arboretum of Harvard University, 22 Divinity Avenue, Cambridge, Massachusetts 02138, U.S.A.) & Thomas A. Zanoni (Jardín Botánico Nacional, Apartado 21–9, Santo Domingo, República Dominicana). Two atypical examples of seed distribution in the Dominican Republic. Moscosoa 5: 216-225. 1989. The seeds of *Melocactus communis* (Cactaceae) are removed from the fruits and transported by the common fire ants, *Solenopsis geminata.* Cattle eat the mature pods of *Acacia macracantha* (Mimosaceae) and transport them. The seeds of the *Acacia* readily germinate in the dung deposited on the ground. Several to many seedlings in each dung deposit can result in the tight clustering of trees in nature. Also, dung beetles, *Canthon violaceus,* observed removing individual seeds of *Acacia* from the dung and transporting the seeds to their tunnels. This contributes to the dispersal pattern of solitary trees of *Acacia.*

Se reporta la diseminación de las semillas del cacto "melón" *Melocactus communis* (Cactaceae) por las hormigas, *Solenopsis geminata,* en la provincia de Pedernales, República Dominicana.

Las observaciones sobre la diseminación de las semillas del cambrón, *Acacia macracantha* (Mimosaceae) indican que hay dos diseminadores. Las vacas comen las vainas maduras y descargan las semillas en el estiércol, sobre el suelo. En este micro-habitat húmedo y abonado (estiércol) las semillas germinan fácilmente. Cada depósito de estiércol contiene varias semillas que pueden germinar, por esta razón se nota que los cambrones crecen agregados.

Los escarabajos, *Canthon violaceus,* sacan las semillas de cambrón de el estiércol y las llevan a hoyos individuales. Esto contribuye al patrón de distribución de árboles aislados.

When Henry N. Ridley wrote his encyclopedic book, "The Dispersal of Plants throughout the World" (1930), he noted that there was no adequate work on the subject at that time and that existing references were brief and scattered. He sought to collate and compare the existing observations and records, and then he stated, "The complete story of dispersal, however, is not yet finished, and there is still a large field of work for observers. . . Travellers in almost any area of the globe, but especially in the tropics, may easily add to our knowledge of this subject." The Caribbean area and Hispaniola are not specifically mentioned in Ridley's book, although H. B. Guppy's classic study "Plants, seeds, and currents in the West Indies and Azores". (1917), is included in the bibliography.

In 1988 the reference most often cited for information on seed and fruit dispersal is the third edition of L. van der Pijl's "Principles of dispersal in higher plants" (1982). This small volume of 215 pages contrasts with the 744 pages in Ridley's "Dispersal" and is regrettably much too synoptic in

presentation and in bibliographic references supporting his text. Again the Caribbean islands and their plants are lacking as the source of examples in discussing the morphology or the vectors of dispersal. Ridley's comment that existing references on dispersal are few and scattered is still pertinent to the Caribbean islands. Observations are needed from and by botanists, naturalists and interested observers and can be assembled, if not published directly. We offer two examples of recent observations of seemingly atypical methods of plant distribution.

The genus *Melocactus,* a barrel-type cactus, produces a perennial cephalium of closely associated nodes or areoles consisting of spines, glochids, flowers and fruits. Plants are known as "Melón espinoso", "Tete d'Anglais", or "Pope's Head". *Melocactus lemairei* (Monv.) Miquel is the name commonly applied to the plants of Hispaniola. Moscoso (1943) listed in addition *Melocactus communis* Link & Otto, a name which is difficult to trace and typify, and *Melocactus intortus* (Miller) Urban, a species now recognized to occur in the Lesser Antilles and north to Puerto Rico and the Bahamas but for which no verifiable record exists for the Dominican Republic.

Most species of Melocactus are now recognized from geographical locations rather than morphological characteristics. Fields studies of variation in populations and the assembly of plants from many geographic areas to be grown together for study seem to be the best way species limits and characteristics can be established. Most species in the Antilles have small pink flowers which produce elongate fruits or "berries", pink in color and tapering at the base. The fruits are tightly packed in the cephalium and, as they mature, appear to be squeezed to the surface of the cephalium. Eventually they rest on the surface of the cephalium or fall to the ground. For a period there was argument in the literature as to whether the fruits were forceably ejected like seeds pinched between fingers or whether they were truly eased free of the surrounding mass of hairs and spines.

It has been suggested that such colored soft fruits should be attractive to birds and dispersed by them. Once when one of us (RAH) was photographing a fruiting specimen of *Melocactus intortus* on Montserrat, a brown thrush swooped down and took the fruit before I could snap my picture. Later, on St. Kitts, we observed that the thrush did not eat the whole fruit but instead smeared the fruit on branches of adjacent shrubs, consuming the pink wall of the fruit and leaving the black seeds adherent in masses to the branches. Such deposits of seeds were extensive, and there was no evidence they were eaten by other animals. One assumes that eventually some seeds dried, were freed of the mass and fell to the ground, where they germinated.

Fig. 1. A cephalium of *Melocactus communis* (Cactaceae) from which the commom fire ant removes the seeds from the fruit and carries them away, Pedernales, Dominican Republic.

On a recent trip to Cabo Rojo, Dominican Republic, we stopped to observe plants of *"Melocactus communis"*. These plants were in general smaller than those of *M. intortus,* familiar to us in the Lesser Antilles. The plants we saw had both flowers and fruit, but to our surprise the pink fruits extending from the cephalium were but hollow shells without the usual contents of numerous seeds and fleshy funicles. As we watched we observed many active individuals of the common fire ant Solenopsis geminata (Fabricus), gathering the seeds and partial funicle from the inside of the fruit and carrying them down the body of the cactus plant to the ground, where we soon lost sight of them. This was not a single fruit of plant, the empty cactus fruits were on each of the dozen or more plants that made up the local population. Some of the empty fruit cases were shrivelling from drying, indicating they had been emptied and exposed for some time. Apparently the empty cases had no appeal to birds in the area, and the pulp was not collected or eaten by the ants.

A search of the cactus literature for comparable observations has been unrewarding. Benson (1982) also had birds snatch fruits he was about to photograph and in part verified the idea that whole fruits are carried away by birds. It has even been suggested that the fruits of *Rhipsalis* have been carried across the Atlantic, and from these, plants of the Cactaceae have

become established in Africa (Anthony 1948, Camp 1948).

There are many observations and illustrations of birds eating into the larger fruits of *Pilosocereus* in the Antilles. The work of McAtee (1947) is frequently cited as the summary paper on the distribution of seeds by birds. Although McAtee suggested birds might eat the pulp and reject the seeds as regurgitated pellets or as excreta. Gunn and Dennis (1976) and Sauer (1982) indicate the question is not settled whether birds do actually carry seeds any distance internally.

Ants, too, are well known vectors or agents in the transport of seeds, usually due to their inadvertent gathering of the seed while collecting the oil-rich elaiosomes found on the seeds of certain families of plants. Berg (1975) reported the existence of 1500 species of Australian plants in 57 genera and 24 families where seeds are regularly dispersed by ants attracted to the elaiosomes. Pijl (1955, 1982) and Kapil et al. (1980) give further references to seed distribution by ants and the nature of the plant body attractive to the ant. Although the ant observed carrying the seeds of *Melocactus* is common in the New World and introduced to scattered locations in Africa and Polynesia, this is to our knowledge the *first report* of ant distribution of *Melocactus* seeds.

Our second observation of unusual seed distribution occurred on the mined-out bauxite lands at Las Mercedes, inland from Cabo Rojo. Considerably bauxite ore remains. The area might again be mined in the future. We were interested in the regrowth of vegetation in this area where no deliberate or purposeful planting had been done. The native vegetation from adjacent unmined areas had encroached at the margins but the scattered trees throughout the of the area were specimens of *Acacia macrantha* Humb. & ex Willd., a species of very wide distribution in tropical America and often considered a weed tree.

The plants, which were to 5 m tall, offered shade and browse to cattle and horses roaming untethered in the area. Most of the trees appeared to be in clumps, but occasional solitary specimens were seen. Trees were of many ages. The youngest seedlings were developing in open areas from old cow dung or pads, with anywhere from six to thirty seedlings per pad. The pods of *Acacia macracantha* do contain some sweet tissue between the seeds and are eaten by the cattle. The undigested seeds deposited in the pads at random in the mined-out area had germinated and developed into the clump plantings we observed.

The possible answer to the single trees we observed might be in our observation of a relatively fresh cow pad that was being excavated by dung beetles. The pad was alive with several dozen beetles actively forming balls of

Fig. 2. Cow dung with seedlings of *Acacia macracantha*. Note the roots below the dung that extended into the soil. Las Mercedes, Prov. Pedernales, Dominican Republic.

the manure, which they proceeded to move across the mined-out area. The beetles acted in pairs, one pulling and one pushing. We tracked dung balls and beetles a dozen yards or more to a spot where one pair of beetles was busy burying the ball. On a hunch, we took the dung ball from the beetles and broke it open to reveal a single seed of *Acacia macracantha*. A dozen more balls were collected and all but one contained at least one *Acacia* seed. A few beetles were collected in alcohol and returned to Cambridge, where they were identified by entomologists of the Harvard Musseum of Comparative Zoology as Scarabaeidae: Coprinae: *Canthon violaceus*.

Pijl (1982) gives no supporting references to his statement (p. 23), "Dung beetles in deserts contribute to germination by burying dung with seeds." Ridley (1930) discusses the role of ants as seed distributors in considerable detail but mentions other insects only briefly and dung beetles not at all However, in our observations it was clear that the inclusion of an *Acacia* seed in the dung ball was pure chance and not a deliberate action of the beetle. The beetle apparently had nothing to gain, for the larvae are not known to attack seeds, especially hard ones. However, it is possible the fermenting action of the dung or its acidity might scarify the seed coat and speed the germination of the seed and the manure would enhance the development of the seedling.

Observations and reports of mammals transporting seeds by ingestion and subsequent excretion are many. Burtt (1929) for Africa and Harris (1965) for the Antilles suggest cattle as agents of distribution of several legumes. Observations of elephants as disseminators (Alexandre 1978, Lieberman et al. 1987) are intriguing in the recent qualitative and quantitative evidence that germination is enhanced by passage through the animal's system and growth is more rapid from the fertilizer effects of dung.

Specific records for the Antilles of cattle distribution of seeds are few. It is suggested by Mooney et al. (in Simpson 1977) that seeds of *Prosopis* germinate better when passed through the digestive system of cattle or horses and that the spread of this important leguminous tree may be associated with the development of pastures in tropical areas. Only on Montserrat in the Lesser Antilles does *Prosopis* occur in dense thickets at the edge of mangrove embayments, where it is presumably introduced and spread by ruminating cattle.

By contrast is the record of *Dichrostachys cinerea* (L.) Wight & Arnott (including *D. nutans* (Pers.) Bentham & *D. glomerata* (Forsk.) Chiov.), often regarded as the worst weed tree of the Caribbean area and especially Cuba. *Dichrostachys* is called marabú or aroma marabú in Cuba, where it has invaded and occupied many hundreds of acres of agricultural land. It was introduced from Africa as an ornamental plant before 1863, for the earliest record is a collection of Charles Wright from a cultivated plant at Retiro, Pinar del Río province, on July 15, 1863. Grisebach in fact described this collection as a new species, *Piptadenia stenadenia* Griseb. (p. 81, 1866), although Fournet (p. 717. 1978) suggested it was introduced accidentally to Marie Galante with a cargo of cattle. Nevertheless, cattle have been responsible for its spread in Cuba. In 1911 and 1912 J. A. Shafer indicated on specimens in the herbarium of the Arnold Arboretum (A) that the plant had formed thickets along the roadsides in Santa Clara and Pinar del Río provinces. By 1928 J. G. Jack indicated on his collections (A) that *Dichrostachys* was a roadside and pasture pest. In 1939 one of us (RAH) recorded that *Dichrostachys* plants were well established along cow paths in southern Las Villas province and especially in pastures at Central Soledad. Cattle were spreading the plant faster than local labor could remove the seedlings. Although the spiny stems were useful in producing charcoal, cutting the woody stems only increased the density of the thickets. Marie-Victorin and Leon (1942) describe the spread of the marabú and call it the king of many areas. Leon and Alain (1951) regard the plants as the plague of the country. In fact, the first experimental use of 2—4—D as an herbicide for woody tropical plants was tried on the pastures of Soledad (Thiman

1948). Surprisingly, nowhere else in the Antilles has *Dichrostachys* become a pest, and for some islands the early records of its presence have not been verified by recent collections.

Thus we add the record of cattle as a vector in the spread and establishment of *Acacia macracantha*. The unusual clusters or grouping of plants encountered on the mined-out bauxite areas can be attributed to germination of several seeds in each unit of cow dung. The occurrence of single plants can be due to the activity of dung beetles is this area of Hispaniola.

We refer again to our initial comment that observations on seed and fruit distribution were lacking for the Caribbean area and we make a few suggestions. Gunn and Dennis have published a "World Guide to Tropical Drift Seeds and Fruits" (1946) which will aid beachcombers or seed collectors in drift areas in the identification of their findings. However, a myriad of problems related to seed drift are presented by the shape of Hispaniola and its location. What is a drift seed inventory of the north coast in contrast to the south coast of Hispaniola? Do differences occur in drift flora on the north and south coasts of the southern peninsula of Haiti? What seeds or fruits are found in Samaná Bay? Years ago Guppy (1912, 1917) studied the drift discharged by the Black River in Jamaica. Do Hispaniolan rivers discharge the same or a comparable volume of seeds? J. D. Sauer's comprehensive descriptive and comparative study of the "Cayman Islands Seashore Vegetation" (1982) can well be emulated in studies of other islands, large or small, in the Caribbean. Gunn and Dennis like Sauer notes the unanswered problems of the establishment, possible or real, of drift seeds as plants along the sea coasts. Both works in fact refer to the observations of T. M. Savage English in 1913 that two species of land crabs "are so destructive to seedlings that the self-establishment of drift species is highly unlikely." However, Howard (1950) observed that "land crabs" carried away seeds of coastal species and, following "feeding" experiments, reported that seeds were apparently taken away, even into burrows of land crabs. Although widely quoted, neither of these observations has been recorded again, judging from the cited literature.

Berg (1975) recorded 1500 species of plants distributed by ants in Australia. Some of the 87 genera and 24 families in this documentation occur in Hispaniola and yet no comparable local observations can be found. Do ants transport seeds of the Euphorbiaceae, Violaceae, Papaveraceae and other families in Hispaniola as they do in other countries? In the magnificent "Genera Palmarum" by Uhl and Dransfield (1987) a very brief sections of less than a page is devoted to "dispersal", but only two references apply to New World palms and not one palm occurring in Hispaniola is mentioned.

Palm fruits are eaten by the introduced monkey on St. Kitts (Sade & Hildrech, but what are its food habits on adjacent Nevis, or Martinique, or Grenada where the palms may be different? Introduced monkeys on Barbados destroy vegetable gardens and fruit orchards but are they responsible for the distribution of several unusual weeds on Barbados? What fruits or seeds are truly transported by birds? In a restricted study in Puerto Rico, Bell (1970) and Edmisten (1970) reported their observations on seeds eaten by birds and concluded the method was not evident for the distribution of seeds of *Phytolacca icosandra,* the primary plant in their study. *Arceuthobium bicarinatum* Urban, popularly known as "Conde de pino", is a hemiparasite, if not a complete parasite, infesting only seemingly mature specimens of *Pinus occidentalis* in the Sierra de Bahoruco as well as the Cordillera Central. Other mistletoes are known to have explosive fruits and sticky seeds. However, the most explosive ejects seeds only a few centimeters, and the "explosion" would not explain the wide and seemingly selective distribution of that species. Are birds attracted by the fruits and therefore responsible for the spread of this parasitic plant which affects the growth of a valuable timber tree?

These are but a few of the simple questions that remain without a satisfactory or complete answer for the vegetation of Hispaniola.

BIBLIOGRAPHY

Alexandre, D. Y. 1978. Le role disseminateur des elephants en foret de Tai, Cote d'Ivoire. La terre et la Vie 32: 47–72.

Anthony, H. E. 1948. How *Rhipsalis,* an American cactus, may have reached Africa. J. New York Bot. Gard. 49: 33–387.

Bell, C. R. 1970. Seed distribution and germination experiments Chap. D–6, pp. D–177–182, in H. T. Odum, A Tropical Rain Forest, U. S. Atomic Energy Commission.

Benson, L. 1982. The Cacti of the United States and Canada, Stanford Univ. Press.

Berg, R. Y. 1985. Nyrmecochorous plants in Australia and their dispersal by ants. Austrial. J. Bot. 23: 475–508.

Burtt, R. B. 1929. A record of fruit and seeds dispersed by mammals and birds from the Singida district of Tangayika territorry. J. Ecol. 17: 351–355.

Camp, W. H. 1948. *Rhipsalis* – and plant distribution in the southern hemisphere. J. New York Bot. Gard. 49: 88–91.

Coates Palgrave, O. H. 1957. Trees of Central Africa, R. MacLehgose Nat. Publ. Trust. Salisbury.

Edmisten, J. 1970. Studies of *Phytolacea icosandra.* Chap. D–7, pp D–183–188. in H. T. Odum, A Tropical Rain Forest, U. S. Atomic Energy Commission.

English, T. M. S. 1913. Some note from a West Indian Coral Island. Bull. Misc. Inform. 10: 367–372.

Fournet, J. 1978. Flore illustree des Phanerogames de Guadeloupe et de Martinique. Paris.

Grisebach, A. 1868. Catalogus plantarum cubensium. Leipsig.

Gunn, C. R. & J. V. Dennis, 1961. World guide to tropical drift seeds and fruits. Demeter Press: New York.

Guppy, H. B. 1912. Studies in seeds and fruits. Williams & Norgate, London.

Guppy, H. B. 1917. Plants, seeds and currents in the West Indies and Azores. Williams & Norgate.

Harris, D. R. 1965. Plants, animals, and man in the outer Leeward Islands, West Indies. Univ. Calif. Pub. Geogr. 18.

Howard, R. A. 1950. Vegetation of the Bimini Island Group, Bahamas, B. W. I., Ecol. Monog. 20: 317–349.

Kapil, R. V., J. Bor & F. Bouman, 1980. Seed appendages in angiosperms. Bot. Jahrb. Syst. 101: 555–573.

Lieberman, D., M. Lieberman, & C. Matin 1987. Notes on seeds in elephant dung from Bia National Park, Ghana. Biotropica 19: 365–369.

Leon, H., & H. Alain 1952. Flora de Cuba, vol. 2. Contr. Ocas. Museo Hist. Nat. Col. de la Salle 10.

Marie-Victorin & Leon 1942. Intineraires Botaniques dans l'lle de Cuba. Contr. Inst. Bot. Univ. Montreal Prem. ser. 41.

McAtee, W. L. 1947. Distribution of seeds by birds. Amer. Midl. Nat. 38: 214–223.

Moscoso, R. M., 1943. Catalogus florae Domingensis.

Pijil, L., van der 1955. Some remarks on myrmecophytes. Phytomorphology 5: 190–200.

——— . 1982. Principles of dispersal in higher plants. 3rd ed. Spring-Verlag.

Ridley, H. N. 1930. The dispersal or plants throughout the world. L. Reeve & Co.: Ashford.

Sade, D. S., & R. W. Hildrech 1965. Notes on the green monkey *(Cercopithecus aethips sabaeus)* on St. Kitts, Nest Indies. Carib. J. Sci. 5: 67–81.

Sauer, J. D. 1982. Cayman Islands seashore vegetation. Univ. Calif. Pub. Geogr. 25.

Seaman, G. A. 1966. Foods of the qual dove *(Geotrygon mystacea)* in the American Virgin Islands. Carib. J. Sci. 6: 177–179.

Simpson, B. B. 1977. Mesquite: Its biology in two desert scrub ecosystems. Dowde, Hutchison & Ross, Inc.: Stroudsburg, Pa.

Thiman, K. 1948. Use of 2–4–dichlorophenoxyacetic acid herbicides on some woody tropical plants. Bot. Gaz. 109: 334–340.

Uhl, N. W. & J. Dransfield 1987. Genera Palmarum. Allen Press: Lawrence, Kansas.